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Driving licences and medical screening in old age. Review of literature and European licensing policies.

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ABSTRACT

Chronological age, per se, seems to be, in the case of mature drivers, only a weak predictor of safe driving performance. However, screening policies based on chronological age are widely used. Nevertheless, lately, more evidence-based policies have been called for. In this paper we first, investigate the evidence for and against having an age-based driver screening policy in place; second, we map and compare the current driving licensing policies in European Union (EU) member states in order to examine the variation; and third, we draw conclusions based on the literature and the policy mapping and provide policy recommendations. We find no evidence from the literature demonstrating that the benefits from age-based driver screening would outweigh the disadvantages, and we find the European policies, to a large extent, coercive and not evidence based. Based on research evidence, the policies are likely to limit the mobility and potentially worsen the safety of older persons.

Keywords: re-licencing, screening, safety, mobility, EU, policy

1. Introduction

As the size of the older population is increasing, managing older road users' safe mobility has become a topic of interest. Providing satisfactory opportunities for independent travel and mobility helps the older population to maintain an independent lifestyle and well-being. Recent studies have demonstrated that the successive cohorts of older persons are increasingly car-reliant in their personal transportation and use cars in their everyday mobility (Hjorthol et al. 2010; INFAS and DLR 2010; Ottman, 2010; Siren and Haustein, 2013). Car driving is, in general, seen as an ideal way of maintaining independent mobility in old age, as it is the safest and often most convenient mode of transportation for older persons (OECD, 2001). The question of the fitness and safety of older drivers has, however, also been widely discussed, resulting in a debate about the meaningfulness of screening and of various measures which aim to identify those older drivers who no longer are fit to drive (e.g. Fain, 2003; Fitten, 2003; White and O'Neill, 2000).

Older drivers' elevated risk for injuries and fatalities in traffic can mostly be attributed to their physical frailty (Evans, 1988), and the observed higher crash risk per exposure that previously was attributed to increasing age, has been shown to be a result of a 'low mileage bias' (Hakamies-Blomqvist et al., 2002). Hakamies-Blomqvist et al. (2002) demonstrated in their seminal paper that an increase in age did not cause higher crash rates per exposure, and that the crash risk was associated with level of exposure in traffic rather than age. Since then, this finding has been repeatedly confirmed by independent studies (Fontaine, 2003; Keall and Frith, 2004a; Langford, Koppel et al. 2008), thus challenging the traditional concept of a direct association between age-related deterioration of safety-relevant driving skills and driving performance. Chronological age, per se, seems to be, in the case of mature drivers, only a weak predictor of safe driving performance at best. However, screening policies based on chronological age are widely used in most European

countries and many US and Australian states (e.g. Insurance Institute for Highway Safety, 2012; Langford et al. 2004b; Meuser, 2008; Mitchell, 2008; White and O'Neill, 2000).

As noted by O'Neill (2012a), ageism, vested interests, and biased conceptions about the ageing process can be traced in the eagerness of regulating older drivers' rights to drive through various screening policies. Lately, however, more evidence-based policies have been called for (Desapriya et al. 2012; O'Neill, 2012b; Salmi et al. 2014; Siren and Meng, 2012), and the trend of measuring impact as relative to the societal investment may be reaching this policy area. Especially during economic hardship, it is indeed in the interest of society to assess whether the costs associated with age-related controls are associated with a distinct road safety benefit.

In January 2013, an EU directive (2006/126/EC) was to be implemented in the member states¹. The directive aimed at a more unified driving licencing policy in the member states which required them to issue driving licences with a validity period between only 10 and 15 years. This meant that all licences issued after the date have an expiration date and need to be re-issued by the time of expiration, given that the driver wants to maintain the right to drive. A seemingly unified system allows, however, a large variation in the institutional practices regarding the management of older drivers. In addition, the implementation of the directive can also be seen as giving an opportunity to revise the national licensing policies into being more evidence based.

In the present paper, we investigate the evidence for and against having an age-based driver screening policy in place by conducting a systematic review of evaluation studies. Then, we map and compare the current driving licensing policies in EU countries in order to examine the variation between the countries, to investigate to what extent the European policies may be evidence-based, and what implications the policies may have. Finally, we draw conclusions based on the literature and the policy mapping and provide policy recommendations.

¹ The EU member states in 2014: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, The Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom.

2. Materials and methods

2.1. Literature review

The literature review was carried out as part of the EU-funded project CONSOL (CONcerns and SOLutions – Road Safety in the Ageing Societies) in 2012, and is based on a systematic Google scholar search including one of the following age related terms - ‘old,’ ‘elderly,’ ‘senior’ or ‘age’ in combination with ‘license’ or ‘license,’ and at least one of the following terms - ‘assessment,’ ‘testing,’ ‘screening,’ ‘renewal’ and ‘driving’ or ‘driver’. In addition, older reviews (e.g. Heikkinen et al. 2010) as well as the literature gathered through the search were scanned for relevant literature references. Finally, project partners checked the list of included studies for completeness and for possible missing national studies not published in English.

2.2. Policy mapping

The information on EU licensing policies was also gathered as part of the project CONSOL in January-June 2012 by using official sources (often electronic, internet-based information provided by authorities). The original sources of information were revisited where necessary in February 2014, as not all member states had implemented the directive 2006/126/EC in 2012.

3. The effects of age-based driver screening: a literature review

The evaluation studies, described in detail in the following, are summarized in Table 1. The studies cover research conducted in the last two decades on three continents (North America, Australia/Oceania, and Europe). There are two types of evaluation studies: those comparing different regions (usually countries or states) with different licensing policies and those comparing historical periods with different policies in force.

[table 1 here]

3.1. Studies from North America

Rock (1998) compared the crash rates in the State of Illinois before and after revision of the driving licencing rules. For the group 69–74 years old, the rules were eased by removing the earlier mandatory driving test from the licence renewal procedure. For the age group 81+ years, the rules were tightened and the licence renewal (with test) was set to every second year and every year for drivers aged 87+ years, where it had previously been every 4 years. The paper concludes that no safety effects could be observed; the new rules neither led to an increase in crashes among the 69–74 year olds, nor did they contribute to a decrease in crashes among the 81+ year olds. McGwin et al. (2008) compared the crash fatality rates before and after a new visual acuity licensing standard for 80+ drivers was implemented in Florida in 2004, and found a significant reduction in their fatality rates, while overall fatality rates in Florida increased. A similar decrease in older drivers' fatality rates was not found in bordering states and was thus ascribed to the implementation of the vision test.

At least seven other American studies (Grabowski et al. 2004; Lange and McKnight, 1996; Levy et al. 1995; Nelson et al. 1992; Sharp and Johnson, 2005; Shipp, 1998; Tay, 2012) compared crash rates in different states with different driving licence policies. A number of these have demonstrated no positive effects from the screening programmes. Levy et al. (1995) compared 50 US states analysing Fatality Analysis Reporting System (FARS) crash statistics, and found only testing for visual acuity to be related to lower crash rates, while adding knowledge tests to the renewal procedure had no significant effect. Lange and McKnight (1996) compared crash rates in two states with age-based testing (vision, knowledge, skill) and in two neighbouring states without

such tests. While there were differences between the states, the paper concluded that there was no evidence for the differences in crash rates, which were due to identification and removal of unsafe drivers. A Canadian study (Tay, 2005) examining the driving licensing policies in five provinces and their related crash rates, found that the stringency of the relicensing requirements was correlated with higher mean crash rates.

A number of these North American studies have, on the contrary, found some positive effects from driver screening, but these effects are, in general, limited to single measures or only some age groups. Shipp (1998) compared fatality rates the US states with different re-licensing requirements and found that policies requiring vision-related assessments were associated with lower fatality rates. Nelson et al. (1992) compared the fatal crash involvement of older licensed drivers in 20 US states, which differed in terms of vision testing requirements for relicensing. Their results too showed that mandatory vision testing was associated with a lower crash involvement risk for older drivers, but the results were not statistically significant for all considered age groups. A more recent study by Grabowski et al. (2004) investigated a number of factors including in-person renewal, vision tests, road tests and the frequency of licence renewal (which may vary in different states) as predictors of older drivers' safety. The results showed that the only predictor of lower crash rates was in-person renewal (as opposed to renewal by post), and that this effect was only observed for those aged 85 years and older. Additional tests, regardless of whether they were medical or tests of practical driving skills, had no effect on safety.

Grabowski et al. (2004) further argued that the reason earlier studies (Levy et al. 1995; Nelson et al. 1992; Shipp, 1998) had found a positive effect of vision-testing, was due to one or more of the following four limitations: (1) the effects of in-person licence renewal and vision test laws were not examined separately; (2) the data were older; (3) state traffic laws unrelated to licensure (e.g. seatbelt laws, speed limit laws) were not controlled for; (4) the heterogeneity in the

response to licensure laws in the younger old and the older old was not recognized. The first limitation also holds for the more recent study by McGwin et al. (2008), who pointed out that the exact mechanism responsible for the association between lower crash rates and the introduction of vision tests for 80+ drivers remained unclear because of lacking evidence for an association between visual acuity and crash involvement.

Sharp and Johnson (2005) tested the effect of different state driving licencing policies (renewal cycle, vision and written test, road test and combined tests) on crash rates in regression analyses, and came to the conclusion that stricter examination of driving, such as both eye tests, paper-pencil test and practical test, lead to better road safety. The study, however, showed methodological weaknesses. The applied level of significance ($p < 0.5$), for example, differs from what is commonly accepted, and the study did not control for other possibly interfering factors on the state-level. Thus, the results cannot be considered as convincing evidence for benefits of driver screening.

As it comes to mobility-related effects, Kulikov (2011) examined the impact of five different state relicensing policies on the reduction of driving and driving cessation of older drivers in the United States. She found that older peoples' driving mobility was influenced by state relicensing policies. According to the results "in person renewal at age 70+", "restricted licensing" (licence allowing driving only e.g., during daylight hours, with additional vehicle equipment) and "peripheral vision testing" significantly reduced the likelihood of driving reduction and/or cessation, while "mental testing" and "accelerated renewal" (i.e., age-based shorter licence validity) significantly increased driving reduction and cessation. The author recommended restricted licensing as "a potential mechanism for extending the years of independent mobility for older people" (p. 15). Support for restricted driving also comes from a Canadian study (Nasvadi and Wister, 2009). Comparing crash records of restricted and unrestricted older drivers over a 7-year-

period (1999- 2006), it was found that the risk of causing a crash was 87% lower for restricted drivers compared to unrestricted drivers after controlling for age and gender. In addition, restricted drivers kept their licence longer than unrestricted drivers and continued to drive crash free longer.

3.2. Studies from Australia and Oceania

An Australian study (Langford et al. 2004a) compared older (80+ years old) drivers' crash rates in Melbourne, where no age-based screening is used, and in Sydney, where drivers have to undergo a medical assessment and a driving test at the age of 80. They observed no safety benefit for the seniors in Sydney in this study; on the contrary, crash rates per-licence-issued basis and time-spent-driving basis were even higher in Sydney. Another Australian study (Langford et al. 2004b) compared older driver crash statistics in six Australian states with different licensing policies. The results showed that the older driver crash rates were lowest in Victoria, the only state without age-based mandatory screening. Furthermore, Langford et al. (2008) studied the effects that screening policies for older drivers had on other road users' risk of being killed by an older driver. They found no demonstrable safety benefits from age-based mandatory screening programmes, in terms of either the total number of fatalities or the number of deaths of other road users. Ross et al. (2011) investigated the effect of age-based testing among older Australians, comparing data from states with different mandatory age-based screening practices. They found that older adults required to undergo an age-based medical testing were between 2.2 and 1.5 times more likely to report not driving. Moreover, the percentage of drivers with cognitive or visual impairments was similar in the states regardless of age-based testing policy.

Keall and Frith (2004b) evaluated a newly introduced driving licencing policy for older drivers in New Zealand. The new policy included a practical on-road driving test that had to be completed every two years from the time the driver turned 80. The evaluation study examined the

crash record of all drivers who passed the test (after one or more attempts) within the first three years of operation. The results indicated that each driving test failure prior to passing the driving test was correlated with an increased crash risk of 33% when other driver characteristics, such as age and gender, were controlled for. The authors concluded that the results indicated that the driving test had the ability to identify elevated crash risk. Whether or not this finding is age-related in any way (i.e., whether or not repeated failing of a test would predict crash liability for all age groups) is, however, unknown. In addition, the authors did not discuss the societal/safety impact of 33% risk increase. If the crash rate was low and the target group size was small to begin with, an increase of 33% in risk may not have marked safety consequences.

3.3. Studies from Europe

In the European context, Mitchell (2008) compared seven European countries with different driving licencing policies for older drivers. He found that the ratio of fatality rates for older drivers relative to the rates for middle aged drivers were lowest in countries that had fewer requirements for licence renewal and, thus, a higher level of licence holding for older car drivers. Hakamies-Blomqvist et al. (1996) compared crash rates in Sweden, where there is no age-related screening, and Finland, where all drivers aged 70 or more have to go through a medical check in order to renew their licence. The results did not show any safety benefits resulting from the Finnish system, but, on the contrary, showed that Finland had a higher pedestrian fatality rate for people aged 70 and older. The authors argued that by triggering a modal shift from being a car driver to being an unprotected road user (pedestrian, cyclist, moped rider), the screening indirectly caused an increase in the number of unprotected road users who were killed, and concluded that the age-based mandatory screening thus produced an overall negative safety effect. They also suggested that the screening may have had an effect on the wrong subgroups, i.e. on people who were more sensitive

to social pressure and had a high feeling of subjective risk, but were safe drivers. This is consistent with findings of other studies as well (Langford et al. 2004a; 2004b; Siren and Meng, 2012).

Siren and Meng (2012) compared the number of fatal crashes before and after a screening for cognitive impairment was included in the existing screening procedure in Denmark in 2006. The authors did not find any safety benefits of the addition of the cognitive screening to the procedure, but observed an increase of the number of fatalities in unprotected road-users, possibly due to a modal shift from car driving to walking and cycling.

Finally, the Dutch road safety institute SWOV conducted a literature study to estimate the road safety effects of raising the minimum age from 70 to 75 for the medical examination for driving licences in the Netherlands (Vlakveld and Davidse, 2011). The review concluded that instead of raising the minimum age, the age-related medical examination should be completely abolished.

3.4. Summarizing the results from the evaluation studies

In sum, there is no evidence that a general age-based screening has safety benefits. There are some positive effects found for single measures, namely vision testing, in-person renewal and restricted driving (all in the North American context, and mostly for the oldest age groups). In addition, the few existing studies from Europe conclude that aged-based licence renewal was associated with *negative* safety effects for older people.

4. Driver licensing policies and age-related screening of older drivers in EU

We mapped the driving licence policies in the 27 EU countries with regard to the validity of the licence (category B), the medical requirements to renew the licence, and the respective applied age limits. Table 2 provides an overview of the policies.

[table 2 about here]

4.1. Periodicity of license renewal

While the EU directive requires the licences to have validity between 10 and 15 years, the validity period, in general, shortens for older drivers. Only in nine countries out of 27, was the periodicity the same (10 or 15 years) throughout all age groups. The remaining 18 policies showed great variation related to driver's chronological age. Ages 60, 65 and 70 are typical turning points after which the periodicity shortens. The periodicity after 70 years of age is often two to three years. The periodicity is, however, usually not fixed in the sense that it can be shorter if there is a reason (e.g., health condition).

4.2. Requirements on medical assessment

Not all, but the majority of EU countries (21 out of 27) have driver screening, i.e., they require proof of fitness to drive in connection with license renewal. This is usually a certificate issued by a physician, based on an examination performed by a general practitioner (GP). Variation exists, however. Some countries require an assessment by medical specialists (such as cardiologist or psychiatrist), and, in the UK, the authorities rely on the drivers' self-reports. In countries without mandatory proof in connection with renewal, the drivers themselves, family members, or physicians are to report any illnesses or health related conditions that can have an impact on fitness to drive. Nevertheless, a clear majority of the countries with age related fitness to drive assessments rely on fixed obligatory procedures at prescribed intervals, usually performed by GP's.

There is variation in the methods used for the assessment and which aspects of driver fitness are addressed, but the assessment in most cases is an examination of basic physical

functionality: eyesight, hearing, and general health status. In some countries, visual acuity tests, or psychological or neurological items are included. In Sweden, where no proof of fitness to drive is required for relicensing, more focused driver assessments were carried out on demand (e.g., after physician's report) by multidisciplinary teams in centres for traffic medicine (Levin et al. 2012).

The age at which the proof for fitness to drive is required for first time in connection with licence renewal, varies too. There are a few countries where the requirement is not age-related, that is, all drivers wishing to renew their license need to provide a proof for fitness to drive, regardless of age. In most of the countries this age limit however ranges from 50 to 70 years, 70 years being the most common (in eight countries).

4.3. Costs of license renewal

We also examined the costs related to license renewal in the different countries. This information is likely to quickly become outdated and thus not included in the table. The costs to the licence holders are mostly dependent on the practices required for licence renewal, the respective testing procedures and experts involved. The only country where the medical assessment is free of charge for older drivers is Cyprus. In the remaining countries, costs vary greatly with especially high costs if practical driving exams are needed. The lower fees range between 15 and 20 € but go up to over 100 € (2012 prices). Also, the in-depth fitness to drive assessments in the UK for those drivers whose fitness is in doubt are costly (approximately 120 € in 2012), although the licence renewal is free of charge.

The overt, direct costs have to be borne by the licensee in most countries and are not covered by health care. However, there are indirect costs of the procedure to be borne by society. In most cases, the driver fitness examinations are subsidized so that the licensee only pays part of the

real costs. In addition, coordinating a screening system involving the licensing authorities, health professionals and the licensee bears some costs that society is responsible for.

5. Implications of the age-based driver screening policies

5.1. Safety

As the literature review demonstrated, age based screening, in general, has no positive safety effects. Rather, research suggests that stopping older people from driving may influence safety negatively. At present, the unprotected modes of transport are significantly less safe for older persons. Because of their physical frailty this is especially problematic for women and the oldest old (e.g. Hakamies-Blomqvist et al. 2004; Kirk et al. 2003; Li et al, 2012; Meuleners et al, 2006; Stevens and Sogolow, 2005).

The fact that most of the EU countries do have age-based driver screening policies in place indicates that the policymaking on this particular area is not evidence-based. Based on the literature, the safety outcomes of having these policies are neutral at best, but may also be negative. Stringent screening policies may especially have a negative impact on older persons' safety, if the general infrastructure does not support safe pedestrian and bicyclist mobility.

5.2. Mobility

Mobility is important for the quality of life for older persons, and is often connected to well-being, independence, and the sense of being empowered in old age (e.g., Fonda et al. 2001; Gabriel and Bowling, 2004; Metz, 2000; Ragland et al. 2005). The requirement for older people to renew their driving licences more often than younger people has been found to be significantly related to increased driving reduction and cessation (Kulikov, 2011). Driving cessation, in turn, is associated with a decrease in activities outside the home (Harrison and Ragland, 2003; Marottoli et al. 2000;

Rosenbloom, 2001), a decrease in mobility options (Peel et al. 2002; Taylor and Tripodes, 2001), and negative health outcomes (e.g., Edwards et al. 2009; Mezuk and Rebok, 2008; Ragland et al. 2005).

Previous research has shown that coercive renewal policies especially make women likely to stop driving prematurely, that is, when still fit to drive (Hakamies-Blomqvist and Wahlström, 1998; Rimmö and Hakamies-Blomqvist, 2002; Siren et al. 2004; Wilkins et al. 1999). In addition, older women more often than men tend to suffer from non-fatal, long term conditions that do not hamper the ability to drive a car, but affect the physical mobility and, thus, make daily transport by alternative modes difficult (e.g., Leveille et al. 2000), which makes the mobility disadvantage due to premature cessation even worse.

Many of the European renewal policies are coercive in a sense that they require both frequent renewals and proof of driver fitness in connection with renewal. Many older European drivers need to renew their licenses every second or third year. The age limits of renewal and medical assessment seem to be set ad hoc, given that they are not based on the current knowledge on age and crash propensity or risk (Hakamies-Blomqvist and Henriksson, 1999; Langfor et al. 2006), nor on epidemiological knowledge on the age-related incidence of diseases influencing driving skills (e.g., Alzheimer's Disease International, 2008). Having these types of coercive policies signalizes that society finds car driving by senior citizens a questionable, even suspect activity, and may encourage people to give up driving, even if they still were fit to drive.

An institutional barrier for supporting older people's mobility may be the decentralised public management and the consequent lack of linkage between driver licencing authorities, whose remit predominately is safety, and other transportation authorities with a remit for mobility, despite the fact that both may organisationally be a part of national transportation agencies.

5.3. Cost-efficiency

Age-based screening of drivers is an example of a societal investment that seems to make sense at first glance, but fails to produce the desired benefits (e.g., Siren and Meng, 2012). Research evidence has indicated that, on a traffic systems level, this measure even decreases overall safety and mobility and is associated with various direct and indirect costs for the older drivers themselves and for society as a whole. Research clearly suggests that the focus on managing older road users' safe mobility in a cost effective way should, therefore, shift from identifying and removing at-risk drivers to prolonging older persons' safe driving careers by better accompanying the process of continuing to drive and by enhancing the safety of older unprotected road users.

In addition to the indirect costs from mobility loss and potential increase in traffic fatalities, the screening itself bears some direct costs to the society. This means that especially those countries, where the age limit for requesting an assessment of fitness to drive is low, may face considerable societal costs when the cohorts with higher licence holding rates reach ages when proof of fitness needs to be repeatedly provided. A recent Danish study showed that, among the current cohorts in their 70's, a vast majority holds a license, and also renew it without problems at the first renewal milestone at 70 years (Siren and Haustein, 2014). The renewal rate can be expected to become even higher for the baby boom cohorts.

5.4. Methodological aspects

Assessments of older people's ability to drive are not evidence-based and fail to meet the criteria for a relevant screening programme (Salmi et al. 2014). Overall, research so far has failed to demonstrate that age-based screening procedures decrease the number of crashes. Possible reasons for this are related to the methodological aspects of the assessments.

First, screening aims to assess “individual risk”, which has been criticised conceptually (Hakamies-Blomqvist, 2006). It is indeed questionable whether individual risk can be conceptualised and evaluated in a reliable way. On an individual basis, it is not possible to predict who will be involved in a crash if he/she is allowed to drive. Most at-risk drivers never have crashes, as they, on an individual level, are rare and multi-determined. *Second*, all screening methods carry a considerable level of uncertainty (Hakamies-Blomqvist, 2006; Langford et al. 2008). Depending on the chosen balance between sensitivity and specificity, either some cases are missed or a number of older drivers lose their automotive mobility. *Third*, previous research has shown that mandatory age-related screening measures may have an effect on subgroups other than the one which was originally targeted. There is evidence that many older persons, especially older women, choose to give up driving prematurely if the license renewal procedures require them to be screened (Hakamies-Blomqvist and Wahlström, 1998; Siren et al. 2004). Their mobility thereafter is likely to be maintained through less safe modes of transportation. *Finally*, the lack of the desired safety effects of screening may reflect the fact that older drivers with cognitive or other medical impediments do not pose a notable safety hazard in the traffic system. Cognitive impairments have been found to be associated with reduced levels of driving and voluntary driving cessation (Donorfio et al. 2008; Kostyniuk and Molnar, 2008; Lyman et al. 2001; Rimmö and Hakamies-Blomqvist, 2002). The reduced presence in traffic directly contributes to a lower absolute risk of crashes. Consequently, removing these drivers from the driver population will, at best, prevent a very small number of crashes.

In a recent paper, Salmi et al. (2014) point out the very purpose of any screening programme: the early detection of a disease with potentially severe consequences is expected to improve prognosis by facilitating timely treatment. If driver’s fitness assessments are assessed

against the general criteria for assessing the relevance of a screening programme, they fail, because the potential benefits do not outweigh the disadvantages (Salmi et al. 2014).

5.5. Ethical aspects

Losing a driving licence has been shown to have a number of negative outcomes for older drivers with regard to safety, mobility and health. From an ethical point of view, any measures that may lead to premature driving cessation should thus be justified by clear evidence which shows that the benefits for society outweigh the disadvantages for older people. Even if there were positive outcomes for society as a whole it would be a difficult task to balance the pros for society and cons for older people in an ethical way. Given the lack of evidence for building a case for age-based driver screening, there is no ethical basis for restricting older people's licences.

Further, the renewal procedure itself produces ethical problems - not only for the person to be screened, but also for those who are in charge of the decision to either renew or not to renew a person's licence, especially if it is the older driver's family physician (Somerville et al. 2010). Several studies have demonstrated that physicians carrying out driver fitness assessments may face problems in this task (Hakamies-Blomqvist et al. 2002; Jang et al. 2007; Marshall et al. 2012; Sims et al. 2012; Wilson and Kirby, 2008). These problems lead to concerns about doctor-patient relations and legal liability, as well as to less substantiated judgments.

In European policies, the role of general practitioners seems to be dominating in the assessments, although previous research has indicated that they do not necessarily possess the needed knowledge on ageing and driving fitness or feel confident in doing the driver assessments. Previous research has stressed the importance of multidisciplinary assessments and the need of specialized training in any fitness to drive evaluations (e.g., Larsson et al. 2007; Sommer et al.

2004; Marshall et al. 2012), but, the recommendations do not seem to have transferred to the practices in place.

6. Conclusions

Previous research has demonstrated that older drivers, per se, are a safe group of drivers, and that they do not pose a threat to other road users' safety (e.g. Dellinger et al. 2004; Evans, 2000; Lafont et al. 2010). Against this background, a general screening of the whole population of older drivers does not appear reasonable from a cost/benefit perspective. In addition, losing a driving licence has a number of negative outcomes for older drivers with regard to safety, mobility and health. To take away the licence would only appear justified if it was possible to reliably identify unsafe drivers. The existing measures, however, fail in that respect. Apart from the negative consequences for the older person who has to cease driving, the relatives (who have to take care for the older persons' future transport needs) are concerned. Finally, the GPs, when in charge of this decision, often find themselves in a dilemma of not wanting to restrict their patient's mobility on one hand, and having concerns over the person's driving ability on the other hand.

Already in 2008, a paper by Langford et al. (2008) was set to facilitate the translation of research based knowledge into policies by outlining the main messages from research to policy makers in the area of driver licencing. Nevertheless, many of the current policies are not consistent with research findings. Given this lack of evidence-based knowledge in current driver licencing policies and guidelines – as demonstrated both in our paper and other recent scholarship (Salmi et al., 2014) – linking modern research evidence with driver licencing practices has remained a major challenge.

While older persons are increasingly reliant on cars for their personal transportation, and likely to safely continue driving into advanced ages, it is likely that also, in the future, many older

drivers experience a period of post driving cessation in their lives. Recent research suggests that training and pre-planning giving up driving may mitigate the negative consequences post driving cessation (Musselwhite, 2010; Musselwhite and Shergold, 2013). As the risk of getting injured or killed is higher for older people as pedestrians, cyclists and passengers of public transport, it is also important to support older persons early enough in the safe use of alternative modes of transport to mitigate the end of their driving career and related feelings of dependence and restricted mobility. People without access to public transport, or no ability to use it, should be provided with compensatory services, such as door to door service or taxi vouchers. Some new thinking regarding transport policies serving the older persons mobility may also be beneficial. In the US, car sharing and informal transport services have been shown to have great potential (Freund and Vine, 2011). A recent paper from the UK challenges the traditional view on great car dependency in rural areas, and points out the localised nature journeys and the potential for other modes even in a rural setting, and recommends more emphasis to be placed in rural transport policy on facilitating short range travel for social purposes (Shergold et al. 2012).

Based on our review, we recommend that policymakers shift the focus of managing older road users' safe mobility to prolonging older persons' safe driving careers, instead of restricting their mobility and exposing them to the higher risk of unprotected transport modes. Women especially often give up their licence when they are still fit to drive (Siren and Haustein, 2014; Siren et al. 2004) and could be even more encouraged to do so by an extensive renewal procedure. If the population based health visits at certain ages are seen as a necessary societal investment, we recommend these visits to have more meaningful scope than that of traffic safety only. Providing a general health assessment for seniors at certain age milestones, for example, would not only be less ageist but also serve a purpose in public health promotion and disease prevention (cf. Salmi et al. 2014). Nevertheless, a possible obstacle to a paradigm shift from identifying and removing at-risk

drivers to prolonging older persons' safe mobility might be the fact that designing and selling "tests" that are supposed to measure individual driver safety is a large business and there are, therefore, enormous vested interests and heavy lobbying towards the governments to have extensive older driver testing programmes.

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Table 1. Studies examining the relation between safety or mobility outcomes and different licence renewal procedures for older drivers

Authors, year of publication	Setting	Methods/Design	Main outcome	Conclusions, comments	Safety effect
Grabowski, Campbell, Morrissey, 2004	All US states (1990-2000)	Retrospective, longitudinal study conducted 1990-2000 of all fatal crashes in the US, which involved older drivers of three age groups (65-74; 75-84; 85+) or middle-aged (25-64) drivers. In two regression approaches the effect of state laws mandating in-person renewal, vision tests, road tests, and frequency of licence renewal on driver fatalities were studied.	Among individuals aged 85+, states with in-person licence renewal were associated with a lower driver fatality rate. Vision tests, road tests, more frequent licence renewal, and in-person renewal for individuals aged 65-74 and 75-84 years were not independently associated with the fatality rate among older drivers.	State-level factors (e.g. number of licenced elderly drivers, traffic laws, per capita income) were controlled for. Limitations and differences to the results of other studies (esp. w.r.t. vision testing) are discussed thoroughly.	+ [in-person renewal] 0 [other measures]
Hakamies-Blomqvist, Johansson, Lundberg, 1996	Finland (age-based medical screening); Sweden (no age-based screening) (1990)	Comparing injury accidents, fatality rates of car drivers and passengers, and fatality rates of unprotected road-users between Sweden and Finland.	Similar age-related variation in injury accidents and car fatality rates among Finland and Sweden. Higher age-related increase in fatality rates of unprotected road users in Finland.	No safety benefits of ages-based screening but possibly shift of older drivers to unprotected modes with higher accident risk. Authors discuss possibility that older driver screening makes relatively safe drivers cease driving and keeps unsafe drivers on the road.	0/-
Keall, Frith, 2004	New Zealand (1999-2002)	Evaluation study on a newly introduced licence renewal policy for older drivers. Study population consisted of all drivers 80+ that attempted and eventually passed the driving test in connection with renewal in 1999-2002. The study investigated their crash record and violations.	Each test failure was associated with 33% increase in the odds of crash involvement.	Driving test could identify crash liability. Not known if test failure predicts crashes regardless age and to which extent.	+ [on-road test]
Kulikov, 2011	All US states (1993-2000)	Nationally representative data from four waves (1993–2000) of the Asset and Health Dynamics of the Oldest Old study were linked to state policies on relicensing and used in a longitudinal logistic regression analysis. Driving behaviours of a sample of 9,638 men and women were studied.	The findings demonstrated that the driving mobility of older people was influenced by state relicensing policies. The analysis indicates that five policies—accelerated renewal, mental testing, peripheral vision testing, renewal in person at age 70+ (as opposed to renewal by mail or online), and restricted licensing—have a significant effect on an older driver's decision to reduce or cease driving.	Policies influence peoples' decisions regarding driving. Restricted licensing may extend the years of independent mobility for older people.	No safety effects evaluated
Lange, McKnight, 1996	Illinois, Indiana (age-bases testing); Michigan, Ohio (no age-bases testing) (1991–1992)	Per-driver, accident rates of US states with age-based licence renewal testing (road tests) were compared with those of neighbouring states without such testing.	In US states requiring age-based skill testing, tested drivers had significantly <i>lower</i> relative involvement in injury accidents than their counterparts in the comparison states in single-vehicle accidents (for which the elderly drivers were more clearly responsible) older drivers in the states with age-based testing had <i>higher</i> accident rates.	The ability of age-based renewal testing to achieve significant reductions in unsafe older drivers is questioned by the results as differences could be due to reducing the number of older drivers per se, not older unsafe drivers. Limitation: differences among states, other than their renewal policies, were not controlled for (but were partially controlled by choosing neighbouring states).	0

Authors, year of publication	Setting	Methods/Design	Main outcome	Conclusions, comments	Safety effect
Langford, Fitzharris, Koppel, Newstead, 2004	Melbourne (no age-based testing); Sydney (age-based testing) (1996–1999)	Crash rates per population, per licenced driver, per distance driven, and per time spent driving were compared between Melbourne and Sydney based Poisson regression method.	Drivers aged 80+ years in the Sydney region had higher rates of casualty crash involvement than their Melbourne counterparts, statistically significant on a per licence issued basis and time spent driving basis.	No safety benefits found. Authors discuss possibility that older driver assessment makes relatively safe drivers cease driving and keeps unsafe drivers on the road.	0/-
Langford, Fitzharris, Newstead, Koppel, 2004	Queensland, Tasmania, Western Australia, New South Wales, Victoria, South Australia (1994–1998)	Older driver fatal and serious injury crash involvement rates were compared between Victoria (no age-based screening) and states with different licensing procedures.	On a per-licensing basis, drivers aged 80+ in all states had higher serious injury crash involvement than drivers from Victoria. On a per-population basis, Victorian older drivers were at least as well performed as those from other states.	Various mandatory assessment procedures were not associated with road safety benefits. Limitations are discussed, esp. that the comparisons may be influenced by other differences between the states.	0/-
Langford, Bohensky, Koppel, Newstead, 2008	Victoria (no age-based testing); New South Wales (age-based testing), Australia (1988-2001)	Fatality rates associated with older drivers in both states were calculated for the main categories of road users per number of target drivers and per number of licenced drivers.	No significant differences between the states in terms of the total number of fatalities or the number of deaths of other road users.	Age-based mandatory assessment programs showed no demonstrable safety benefits.	0
Levy, Vernick, Howard, 1995	all US states (1985-1989)	Effect of different state policies for driver's licence renewal (vision tests, knowledge tests, road tests) on fatal crashes involving senior drivers were estimated by regression methods.	Mandatory testing for visual acuity, adjusted for licence renewal period, was associated with lower fatal crash risk for older drivers.	Differences among states, other than their renewal policies, were controlled for.	+ [vision test]
McGwin, Sarrels, Griffin, Owsley, Rue, 2008	Florida (visual test introduced for drivers aged 80+), Georgia, Alabama (2001-2006)	Motor vehicle collision (MVC) fatality rates for all Florida residents and for drivers aged 80+ were compared before and after the implementation of the “visual acuity licensing standard”. Bordering states (Georgia, Alabama) were used as control measures.	The fatality rate, among all age-groups increased comparing the pre-post period by 6%, while fatalities among drivers aged 80+ decreased significantly by 17%; in Georgia and Alabama no changes in older drivers fatalities was found.	Limitations of the study and alternative reasons for the decline in older road users decrease in fatality rates are discussed.	+ [vision test]
Mitchell, 2008	Denmark, Finland, France, The Netherlands, Norway, Sweden, UK	Association between driver licensing procedures in 7 European countries and older driver safety is looked into.	Countries with the highest level of licence holding for older car drivers have the lowest ratio of fatality rates for older drivers relative to middle aged car drivers. Two of the three countries with the most relaxed licensing procedures, have the lowest fatality rate for car drivers aged 65+.	Concludes that there is no evidence that any licence renewal procedure has an effect on the overall road safety of drivers aged 65+. No inferential statistics to confirm the statistical significance of the purely descriptive results.	0
Nasvadi, Wister, 2009	British Columbia, Canada (1999-2006)	Crash records of restricted and unrestricted drivers aged 66+ were compared in a cohort study design.	Risk of causing a crash was 87% lower for restricted drivers compared with unrestricted drivers after controlling for age and gender.	Authors conclude that driving restrictions may be effective for prolonging the crash-free driving of some ageing drivers.	+ [restricted driving]
Nelson, Sacks, Chorba, 1992	20 US states with/without required vision testing for relicensing (1986-1988)	Fatal accident rates in states that conduct periodic vision testing with that in states not requiring such testing were compared, examining the ratios of fatality rates for different groups of 65+ drivers against those of drivers aged 45-64.	Significantly higher ratios in the states without vision testing for 65-74 and 85+ aged drivers vs. 45-64 year-olds ($p < .05$); but not for 75-84 year-olds ($p = .05$).	Other potential reasons for the differences between the states were not considered.	+/- [vision test]

Authors, year of publication	Setting	Methods/Design	Main outcome	Conclusions, comments	Safety effect
Rock, 1998	Illinois (US) (1987-1989; 1995)	Examination of crashes, fatal crashes, crash rates, and licensure rates of senior drivers before and after a revision of the length of licence term and renewal requirements (road test) for older drivers.	Elimination of a road test for age group 69-74 had no negative safety impact. More frequent renewal period for those aged 81+ showed no benefit compared to control group (=75-80 y., no change).	Methodological and data limitations are discussed thoroughly. A policy of 4-year renewal is suggested as being more efficient in an overall cost-benefit sense.	0
Ross, Browning, Luszc, Mitchell, Anstey, 2011	New South Wales, South Australia, Victoria	Logistic regression to analyse how different age based testing policy predicts driving behaviour. Participants were adults aged 65 to 103 (n=5206).	Older adults required to undergo age based testing were between 2.2 and 1.5 times as likely to report not driving. Similar proportions of drivers with cognitive or visual impairments were found regardless of age based testing status.	Required age based testing for license renewal was associated with lower rates of driving. The proportion of drivers with probable cognitive or visual impairments was similar in the states regardless of testing policy.	(0) No direct safety effect was measured
Sharp, Johnson, 2006	15 US states (1990–1999)	Effect of different state policies for driver's licence renewal (renewal cycle, vision and written test, road test, combined tests) on older driver crash involvement estimated by regression methods.	Crash rates are positively related to the length of the renewal cycle for older drivers and negatively related to the stringency of testing at renewal.	Methodological problems. The reported effects are not significant on a commonly accepted level. Existing research in this field is ignored.	(+)
Shipp, 1998	US states (1989-1991)	Effect of state vision-screening relicensing policy on vehicle occupant fatality rate for 60+ aged drivers estimated by regression methods.	Vision-related relicensing policies were significantly associated with lower vehicle occupant fatality rates of older drivers.	Other potential reasons for the differences between the states were controlled for.	+
Siren, Meng, 2012	Denmark (2003-2008)	Number of fatal accidents before and after the addition of screening for cognitive impairment to the existing screening procedure are compared.	No significant difference in the number of older drivers involved in fatal accidents before and after the implementation of the cognitive screening significant increase in the number of unprotected older road users who were killed between the two periods.	Screening had no effect on the safety of older drivers screening process may have produced a modal shift among older persons from driving to unprotected modes of transportation.	0/-
Tay, 2012	5 Canadian provinces (1998-2004)	Effect of stringency of the licensing in five provinces on number of crashes involving ageing drivers by regression methods.	Stringency of licensing for ageing drivers is associated with increase in crashed involving ageing drivers.	Other potential reasons for the differences between the provinces were controlled for.	-
Vlakveld, Davidse, 2011	Literature study	Literature review.	Age-based screening programme is not recommended.		

+ = positive effect on safety; - = negative effect on safety; 0 = no safety effect; 0/- = no overall safety effects, partly negative effects; () = study has limitations that restrict the validity

Table 2. Licensing policies in the 27 EU countries.

COUNTRY	Periodicity depending on age	Age for accelerated renewal and validity periods	Medical statement required	Method for assessing the fitness	Age when medical statement required for first time
Austria	no	--	no	--	--
Belgium	no	--	no	--	--
Bulgaria	no	--	no	--	--
Cyprus	yes	After 55, validity until 70 After 70, 3 years	yes	GP	70
Czech Republic	yes	After 60, 5 years After 65, 3 years After 68, every year	yes	GP	60
Denmark	yes	After 70, 4 years After 74, 2 years After 80, every year	yes	GP + 'dementia test'	70
Estonia	yes	After 65, 5 years	yes	GP	any
Finland	yes	After 70, 5 years	yes	GP	70
France	no	--	no	--	--
Germany	no	--	no	--	--
Greece	yes	After 65, 3 years	yes	GP and ophthalmologist	any
Hungary	yes	After 40, 5 years After 60, 3 years After 70, 2 years	yes	GP	any
Ireland	yes	After 60, 3 years After 70, 1-3 years	yes	GP (usually)	70
Italy	yes	After 50, 5 years After 70, 3 years	yes	GP	50
Latvia	yes	After 60, 3 years	yes	GP	60
Lithuania	yes	After 55, 5 years After 70, 2 years After 80, every year	yes	GP	any
Luxemburg	yes	After 70, 3 years After 80, every year	yes	GP	60
Malta	no	--	yes	not specified	70
The Netherlands	yes	After 70, 5 years	yes	GP	Appr. 70 (earliest at 69, latest 74, depending on issuance)
Poland	no	--	yes	Physical and psychological	any

Portugal	yes	After 60, 5 years After 70, 2 years	yes	GP +Psychological assessment	50
Romania	no	--	yes	Physical and psychological assessment	any
Slovakia	yes	After 65, 2 years	yes	Physical and psychological assessment	65
Slovenia	yes	After 70, 5 years	yes	Specialist in traffic medicine	70
Spain	yes	After 65, 5 years	yes	Comprehensive physical and psychological assessment	any
Sweden	no	--	no	--	--
United Kingdom	yes	After 70, 3 years	yes	self-evaluation, self-report	70